A PRELIMINARY REPORT ON THE POISONOUS EFFECTS OF BITTER RUBBER WEED (ACTINEA ODORATA) ON SHEEP[1]

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INTRODUCTION

Since 1925 a small annual weed, known in western Texas as "bitterweed," has become an increasingly serious menace as a sheep-poisoning plant. This plant, *Actinea odorata*, is related to the Colorado rubber weed, *A. richardsoni*, and the two plants produce very similar effects on sheep.

The attention of the United States Department of Agriculture was first called to the injurious effects of *Actinea odorata* in December, 1925, by W. H. Drew, of Eldorado, Okla. This town is situated in the extreme southwestern corner of the State near the Texas line. Mr. Drew sent to the department a sample of a plant which he said was killing his sheep. He did not state the location of the range in question but said that in his 25 years' experience as a sheepman this was the first time that he had had trouble from this plant. His description of the symptoms shown by the sick sheep correspond very well with those which more recently have been produced experimentally. The specimen of the plant which he sent was identified by S. F. Blake, of the Bureau of Plant Industry, as *A. odorata*.

Attention has since been called to *Actinea odorata* by investigators at the Texas Agricultural Experiment Station. Cory[2] in 1926 stated that the plant is "reported to be called 'lemonillo' * * * we sometimes referred to it as 'bitterweed.'" He stated further that the plant causes the loss of sheep in the latter part of the winter, that under favorable conditions it may bloom in almost any month of the year, that it is a heavy producer of seed, and that proper moisture conditions may be followed by a good growth of seedlings.

Cory[3] in 1926 said also that "bitterweed" causes sheep to become sick and that the plant is eaten only when feed is scarce and no other small green growth is available. He described the general effects of the plant on sheep.

As a result of preliminary feeding experiments made at the Texas Agricultural Experiment Station, Conner[4] in 1929 stated:

> Obnoxious as is this weed, some sheep will eat it during the late winter when other green weeds or grass are not available, or at least are very scarce. Altnough repeated force-feeding tests have not been absolutely satisfactory, they strongly suggest the toxic character of this plant when consumed in large quantities because of the hemorrhagic gastroenteritis found at autopsy.

Schmidt[5] in 1930 stated that sheep eat the bitterweed, especially in the early spring when they are hungry for something green. He

[1] Received for publication May 5, 1931; issued November, 1931.

[2] CORY, V. L. RANGE OF VEGETATION AND THE FEEDING HABITS OF CATTLE, SHEEP, AND GOATS. Sheep and Goat Raisers' Mag. 7(2): 13-18. 1926.

[3] CORY, V. L. RANGES HARBOR POISON PLANTS. ONLY HUNGER DRIVES LIVESTOCK TO EAT HARMFUL WEEDS. Cattleman 13(5): 19-21, illus. 1926.

[4] CONNER, A. B. BITTER WEED (ACTINEA ODORATO[A]). Tex. Agr. Expt. Sta. Ann. Rpt. 42: 141. 1929.

[5] SCHMIDT, H. STOMACH WORMS AND BITTER WEED. Sheep and Goat Raisers' Mag. 11(4):29. 1930.

also stated that sheep have been poisoned by being force fed 2 or 3 pounds of the plant and that the Texas station has no remedy for the poisoned animals.

The National Wool Grower for January, 1931,[6] called attention to the losses due to bitterweed. It stated that "several hundred sections are covered with it * * *. It's spreading each year, an octopus of the range."

Cory,[7] who for several years has been closely associated with the range problems of western Texas, in 1931 called attention to the distribution and the increasing abundance of this plant in that section and emphasized the relationship between the abundance of the bitterweed and the heavy grazing of the range. On January 9, 1931, he wrote to this bureau as follows:

> *Actinea odorata* has become more abundant and more widely spread this season than heretofore. We have recent reports from the Pecos High Bridge country on the southwest and from the Abilene country on the northeast. The trouble due to this plant started earlier than usual this season and is about at its height at the present time. It appears to constitute a serious menace to the sheep industry over a large part of the Edwards Plateau.

Again, on January 26, 1931, he wrote:

> This plant blooms at any time of the year when moisture conditions are favorable, and it seeds heavily. Ordinarily livestock do not eat this plant. However, in the winter months, when it is very abundant, and the only green herbaceous material available, sheep eat it. They apparently form a liking for it, and after some days they get down. * * * After late fall or early winter rains this plant carpets the ground and appears almost as a carpet of fescue grass. There are plants in bloom now, and they may be found in bloom all other months of the year. Ordinarily they cause trouble from January 15 to February 15 here, but the trouble began the middle of December this season.

Although this plant is ordinarily a menace only to sheep, a few correspondents have stated that goats and cattle are poisoned by it.

In view of the foregoing reports and the evident menace of the plant to stock raising, the Bureau of Animal Industry undertook the investigations the results of which are here presented. The author likewise personally examined affected ranges in Texas and obtained first-hand information from livestock owners whose animals had fallen victims to the destructive plant.

The increase in losses from *Actinea odorata* poisoning, to which thousands of sheep succumbed early in 1931, is probably an indirect result of overgrazing the range. This kills out the valuable forage and gives a chance for the less desirable and obnoxious plants to get a foothold and to increase in number. Animals usually eat poisonous plants because of a lack of the proper kinds of feed.

DESCRIPTION AND DISTRIBUTION OF THE PLANT

Actinea odorata, a member of the Compositae, is an annual weed that grows to a height of from 6 inches to 2 feet and has a branching stem. The leaves are alternate and have very narrow or linear divisions. The more or less erect branches terminate in yellow flower heads which are one-fifth to one-third of an inch in diameter. Figure 1 shows the general appearance of this plant.

[6] ANONYMOUS. WEST TEXAS NEWS [BITTERWEED, A RANGE PEST]. Natl. Wool Grower 21(1): 47. 1931.
[7] CORY, V. L. BITTERWEED. Sheep and Goat Raisers' Mag. 11(7): 1926–27. 1931.

Although the term "lemonillo" has been applied to *Actinea odorata* by a few botanists, it is known in western Texas as bitterweed and in places in New Mexico as rubber weed. The name bitterweed,

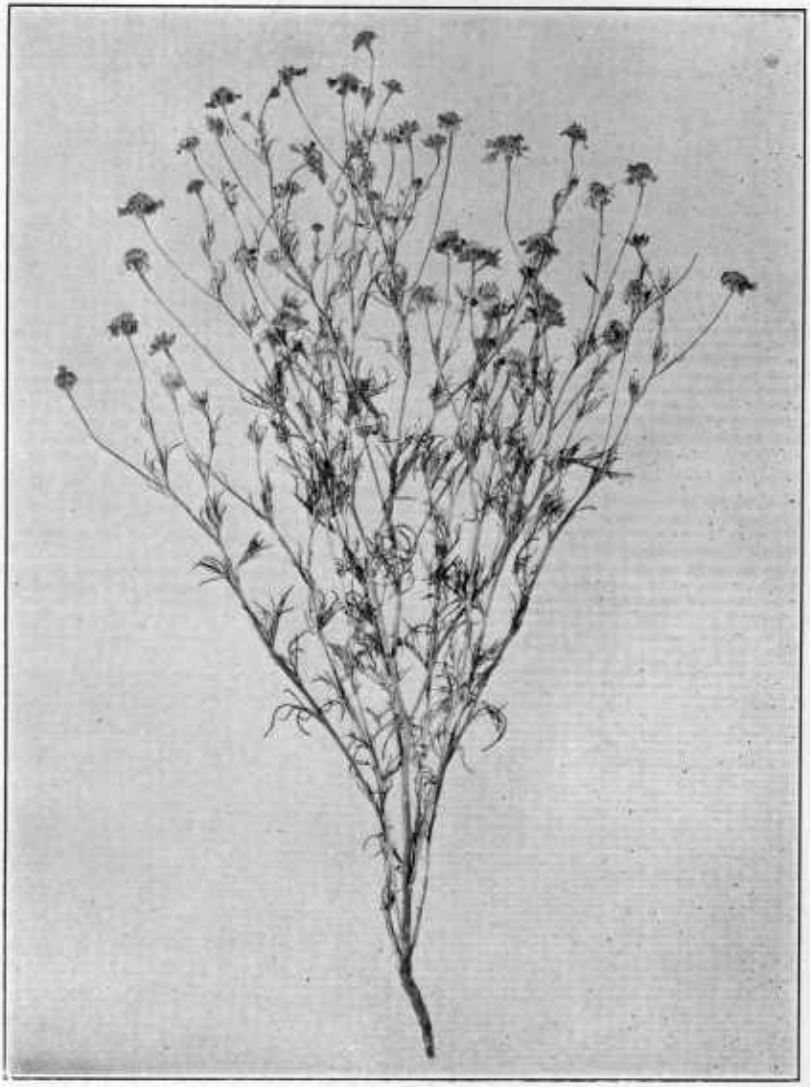

FIGURE 1.—General appearance of bitter rubber weed (*Actinea odorata*). This specimen was about 1 foot in height

however, is much more generally applied to *Helenium tenuifolium*, and the term "rubber weed" is used for *A. richardsoni*. In order to distinguish *A. odorata* from these other plants the name bitter rubber weed[8] is suggested.

[8] "Bitter rubber weed" was suggested by M. W. Talbot, in charge of weed investigations, Division of Botany, Bureau of Plant Industry.

Actinea odorata is distributed from southwestern Kansas and central Texas westward across southern New Mexico and southern Arizona to southeastern California, as shown in Figure 2,[9] and thence southward into Mexico. Its range extends from a little above sea level to an altitude of about 4,000 feet. It is not found in the mountains and, as a rule, it does not occur in areas of high humidity.

Although bitter rubber weed is fairly widely distributed, with one exception the records of animals poisoned by it are all from the Edwards Plateau region of western Texas and east of the Pecos River.

PLAN OF THE EXPERIMENTS

Through the kindness of Edwin Jungherr, of the Texas Agricultural Experiment Station at Sonora, a liberal supply of *Actinea odorata* was obtained in the spring of 1930. This material, consisting of leaves, stems, roots, and flowers, was dried and shipped to the bureau's experiment station at Salina, Utah.

During the summer of 1930 the plant was fed experimentally to 11 sheep. All the dosages were computed in terms of the green plant, 75 per cent being allowed for the loss in weight by the plant in drying. Although no drying tests have been made with *Actinea odorata*, a considerable number with *A. richardsoni* and other plants have shown 75 per cent, by weight, to be a fair estimate of the amount such plants lose in drying. In all the feedings the entire plant, including leaves, stems, flowers, and roots, was used, and in all but one the plants were finely ground, moistened with water, and fed by means of a veterinary balling gun. While the sheep were being used in these experiments they were given a liberal supply of alfalfa hay. The feeding experiments are summarized in Table 1.

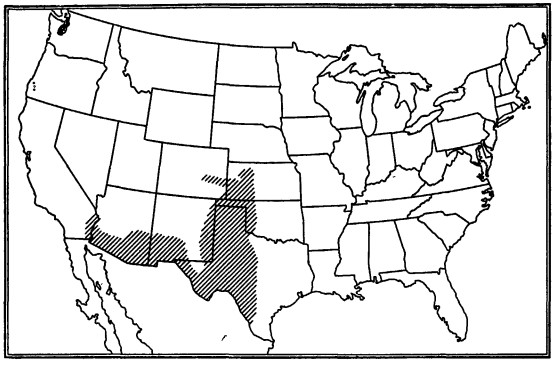

FIGURE 2.—General distribution of *Actinea odorata* in the United States

In an attempt to produce acute sickness, the ground plant was given in a single feeding in seven of the experiments. In these feedings the quantity of dry plant varied from 0.075 to 0.325 per cent of the animal's weight, or from 0.3 to 1.3 per cent of its equivalent of green plant. In the other four experiments the plant was given in small daily feedings for a considerable period. Three of the sheep were given the moistened plant by means of a balling gun, and, in order to distribute it over the day, each day's dose was, as a rule, divided into three parts, one part being given in the morning, one about noon, and one in the late afternoon. One sheep was fed the dry plant mixed with hay. These cases are termed "chronic."

[9] W. W. Eggleston, of the Bureau of Plant Industry, furnished the information regarding the distribution of this plant.

TABLE 1.—*Summary of feeding experiments with Actinea odorata (leaves, stems, flowers, and roots)*

Sheep No.	Weight of animal	Date or period of feeding	Method of feeding	Dose as percentage of animal's weight [a]		Result
				Total	Average per day	
	Pounds					
1150	67	June 17–July 7	Balling gun	5.25	0.25	Very sick.
1152	75	June 20	do	[b] 1.00		Slight symptoms.
1158	81	June 25	do	[b] 1.20		Do.
1161	94	June 27	do	[b] 1.30		Death.
1162	80	July 2	do	[b] .75		Not sick.
1165	76	July 9	do	[b] .50		Do.
1170	93	July 14–Sept. 25	do	7.40	.10	Symptoms.
1185	115	Aug. 6	do	[b] .30		Not sick.
1186	130	Aug. 9–Sept. 7	With hay	7.24	.24	Do. [c]
1187	82	Aug. 9–Sept. 25	Balling gun	4.80	.10	Sick.
1196	102	Aug. 16	do	[b] .40		Not sick.

[a] Estimated as green plant. [b] Given in 1 feeding. [c] Loss in weight the only effect observed.

RESULTS OF THE EXPERIMENTS

SYMPTOMS

The symptoms produced in both the acute and chronic cases of poisoning were very similar. They were principally salivation, nausea, vomiting, depression, and weakness. In the acute cases the pulse was distinctly faster and weaker and the body temperature higher after the feeding than before. In the chronic cases the illness continued for a longer time and the weakness was more pronounced than in the acute cases.

Sheep 1150 is a good example of a chronic case. When this sheep, a yearling ewe, was placed on the experiment June 11, she weighed 67 pounds. She was active, vigorous, and had a very good appetite. After being kept under observation for six days she was given daily, with the balling gun, 12.6 gm. of the dry, finely ground plant. The first day this was divided into two equal doses, one being given at 11.50 a. m. and the other at 2.20 p. m. After the first day each day's dose was divided into three approximately equal parts. These feedings were continued daily through July 7. Computed in terms of green plant, the quantity given each day was equivalent to 0.25 per cent of the weight of the sheep. Each day of the experiment she was given a liberal supply of alfalfa hay. On July 2 she weighed 73.5 pounds.

The first evidence of illness was noticed in the afternoon of July 3, when a foamy liquid was seen about the nostrils. The next morning she was nauseated, there was a quantity of green regurgitated material around the nose and mouth, and she had not eaten all the hay fed the preceding day. At 7.55 p. m. she appeared somewhat weak and walked unsteadily. The symptoms of illness became more pronounced, and by 5 p. m., July 6, she had vomited, her breath smelled strongly of stomach contents, and she was so weak that she preferred to lie down. On the last day on which she was fed the *Actinea odorata*, July 7, she was much nauseated and very weak. Most of the time she was lying down. When on her feet she stood with her back arched and walked with difficulty, and after taking a few steps she

began to tremble noticeably. Her appetite, however, was good. Both the nausea and the weakness became more marked. On July 8 she weighed 62.5 pounds, having lost 11 pounds in six days. On the morning of July 9 she was barely able to get on her feet. Although she had vomited profusely during the night of July 8, she ate hay greedily. During the day she was nauseated and lay down most of the time, and on the morning of July 10, she was unable to stand. She vomited and showed other evidence of nausea for the last time during the night of July 10. She gained strength slowly and at 5 p. m., July 15, she could get on her hind feet but not on her forefeet. When lifted to her feet and held in that position she trembled. She made repeated attempts to get up but was unable to do so until 10 p. m., July 18. At this time she managed to get on her feet with great effort but trembled and had to lie down at once. At 9 a. m., July 19, she got on her feet and stood for a few minutes, although in an awkward manner. Her forelegs were bent at the knee joint, and the feet were drawn back under the body. The forelegs were also bent at the fetlock joints so that she stood almost on the front edges of the hoofs. She was able to stand but a few seconds at a time. Although she gained somewhat in strength she was unable to walk more than a few steps at a time for the next four days. On July 23 she was put into a small pasture where she could be kept under observation. At 1.10 p. m., when disturbed, she got on her feet readily and ran a few steps in an awkward manner. From this time on she slowly gained strength, and the forelegs gradually straightened until on August 6 she stood and walked in a practically normal manner. At this time she was still somewhat weak and thin, and she did not regain her usual activity until about August 19, when she weighed 66 pounds.

This sheep gained in weight up to the day before definite symptoms were noted, but after that she lost flesh rapidly. She was not weighed during the period of most severe illness, but from August 3 until September 15 she gained steadily. The rate of respiration during the first part of the feeding period did not vary to any great extent, but during the latter part of the feeding and up to the time she began to show marked improvement it varied greatly.

On September 26 she was shot. The autopsy was negative, except for a slight enlargement of the lymph glands associated with the stomachs.

TIME BETWEEN FEEDING AND APPEARANCE OF SYMPTOMS

When *Actinea odorata* was fed in a single large dose, cases of an acute type were produced. For these the time from the end of the feeding to the first appearance of symptoms is shown in Table 2.

TABLE 2.—*Time between feeding and appearance of symptoms in animals fed a single large dose of Actinea odorata*

Sheep No.	Dose as percentage of animal's weight [a]	Time between feeding and appearance of symptoms	
		Hours	*Minutes*
1152	1.0	20	26
1158	1.2	6	30
1161	1.3	5	50

[a] Estimated as green plant.

In cases of this kind in which loss of appetite and depression are the first symptoms noted, it is of course impossible to give a definite time for the appearance of the effects. The time when some abnormality in the animal's actions or condition was first observed is taken as the beginning of symptoms. It is realized, of course, that the figures given in Tables 2 and 4 are, in a sense, approximations, because it would be quite impossible accurately to ascertain that an animal was well one minute and ill the next, or vice versa, but it has been thought best to present the actual experimental results as obtained. In the three animals given a single large dose of the plant the time from the feeding to the appearance of symptoms varied from 5 hours and 50 minutes to 20 hours and 26 minutes, and averaged 10 hours and 55 minutes. The larger the dose the sooner the symptoms appeared.

The reports of field cases indicate that sheep are more commonly poisoned by eating small quantities of the plant at frequent intervals for a number of days than by eating large quantities at one time. In order to determine the quantity a sheep must eat daily to be affected four sheep were fed for a considerable period. When small repeated feedings were given it was found that very small daily doses if continued for a sufficiently long time would cause illness. The time required to produce symptoms in these four cases is shown in Table 3.

TABLE 3.—*Time between the beginning of experimental feedings with Actinea odorata and the appearance of symptoms when small daily doses were given*

Sheep No.	Average daily dose as percentage of animal's weight [a]	Time between first feeding and appearance of symptoms
		Days
1150	0.25	17
1170	.10	44
1187	.10	46
1186	[b].24	[c]23

[a] Estimated as green plant. [b] Mixed with hay. [c] Loss in weight the only symptoms shown.

Sheep 1150, which was given daily 0.25 per cent of its weight of the plant, showed symptoms of illness in 17 days, and after 19 days it was very ill. The feeding was continued for 21 days during which the sheep was given a total dose of 5.25 per cent of its own weight. At the close of the feeding it was thought that the animal had probably received a lethal dose. However, it made a partial recovery.

Of two sheep, each given a daily dose of 0.1 per cent, one showed slight but distinct symptoms of poisoning after it was fed for 44 days and the other after 46 days. The feeding of these animals continued at the same daily rate after the symptoms were noticed. One sheep remained in about the same condition, showing evidence of slight poisoning. It was fed a total dose of 7.4 per cent of its own weight in 74 days. The symptoms of the other sheep became more pronounced, and after 48 days of feeding it was distinctly ill.

The fourth sheep, No. 1186, was fed the *Actinea odorata* mixed with hay. Although it did not become distinctly ill, it began to lose

in weight after it had eaten the plant for 23 days. During this time it ate an average daily dose of 0.24 per cent of its own weight.

From these experimental cases it is apparent that a daily dose of 0.1 per cent of the weight of the animal may produce distinct symptoms of poisoning in 44 days and more pronounced illness in 48 days, whereas a daily dose of 0.25 per cent may produce symptoms in 17 days and severe illness in 19 days.

DURATION OF ILLNESS

Inasmuch as the acute and chronic cases differed materially in duration of illness, they are considered separately. The lengths of time during which symptoms were observed in the three acute cases are given in Table 4.

TABLE 4.—*Length of the periods of illness for the three sheep fed single large doses of Actinea odorata*

Sheep No.	Daily dose as percentage of animal's weight [a]	Duration of illness		
		Days	*Hours*	*Minutes*
1152	1.0	3	8	14
1158	1.2	2	16	27
1161	1.3	----------	[b] 12	----------

[a] Estimated as green plant. [b] Died.

The average duration of the illness in the two sheep that recovered was 3 days and 20 minutes. The sheep that died lived about 12 hours after it became sick.

For the sheep fed *Actinea odorata* daily for a protracted period, the duration of illness has been measured by the time they were sick after the last feeding. Two of the sheep made ill by this method of feeding were shot for autopsies at the end of the feeding period. This leaves but one animal, No. 1150, from which to determine the duration of illness. This sheep was more or less ill for 33 days and at the end of that time she was still thin and had not entirely regained her strength.

The duration of illness in both acute and chronic cases is at best an estimation. There is no sharp line between illness and recovery. In fact there is some question as to the final complete recovery of such cases.

AUTOPSY FINDINGS

An autopsy was made of one animal that died from acute poisoning. The pathological changes were well marked and were evidently due to the action of a severe irritant on the walls of the first and fourth stomachs and of the duodenum. The mucosa of the rumen, especially about the opening of the esophagus, was congested. On the outer surface of this organ, especially in the groove between the first and second stomachs, and along the anterior edge of the spleen there was a mass of coagulated serum. The mucosae of the fourth stomach and of the duodenum were inflamed, and the wall of the fourth stomach was somewhat edematous. Injurious effects were not apparent in the other organs.

Two sheep that had been given daily doses of the plant for 48 and 74 days, respectively, were killed at the end of the feeding period. The results of the autopsies on them were negative. The one animal that was very sick was not killed until its condition had very much improved. The lymph glands near the stomachs in this sheep were somewhat enlarged. Otherwise, nothing abnormal was found when the autopsy was made.

SUMMARY

Actinea odorata, known in western Texas as bitterweed, a plant of the semiarid Southwest, is distributed from southwestern and central Texas to southeastern California and southward into Mexico. On the Edwards Plateau of Texas it seems to have been increasing rapidly in abundance since about 1925 and now appears to be a serious menace to the sheep industry.

Feeding experiments have demonstrated that the plant is toxic to sheep, the principal symptoms produced being salivation, nausea, vomiting, depression, and weakness.

These experiments have shown that if a sheep consumes 1.3 per cent or more of its own weight of the green plant within a short time, fatal results may follow. They have shown also that when a sheep eats as little as 0.1 per cent of its weight of the plant daily it may become ill in about 44 days, and that larger daily doses will produce effects in a correspondingly shorter time.